Agricultural Economics RESEARCH

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UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Marketing Service
Agricultural Research Service

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AGRICULTURAL ECONOMICS RESEARCH

A Journal of Economic and Statistical Research in the United States Department of Agriculture and Cooperating Agencies

Volume XII | APRIL 1960 | Number 2

Farm Capital Gains—A Supplement to Farm Income?

By Ernest W. Grove

Net farm income has shown a generally downward trend since the postwar highs of 1947 and 1948. Even with allowance for nonfarm sources of income and for declining numbers of farms, average farm family income has lagged behind the steadily rising levels of nonfarm family incomes. But the farmer has had an additional return of sorts in the increased capital value of his assets—farm land and buildings and, to a lesser extent, working capital. Such increments in capital value are not included in regular estimates of gross and net farm income because the latter are designed specifically to measure returns from farming operations only. Capital gains and losses are purposely omitted from the estimates of income from farming. Capital gains and losses are referred to here in their general economic sense of changes in capital values associated with price changes, not in any specific tax sense. There is a difference of opinion among economists as to the desirability of lumping capital gains and losses with ordinary income. But some agricultural economists would argue that farm capital gains have been a clearly recognizable supplement to farm incomes in recent years, and most would probably concede that capital gains or losses have some bearing on the economic welfare of farm operators and their families, especially owner operators. Reasonably satisfactory information is available for an assessment of the approximate magnitude and general significance of farm capital gains and losses. Without necessary commitment to either side of the argument, therefore, it is the purpose of this study: First, to raise the basic question concerning farm capital gains and losses; second, to discuss some of its implications in terms of various possible answers; and third, to develop estimates of the average amounts involved annually in the last 20 years.

THE EXTENT to which farmers may have benefited since January 1, 1940, from increased values of farm land, buildings, machinery, and inventories of crops and livestock is indicated in table 1.[1] This table compares farm capital gains or losses with net farm income, in terms of averages per farm, for each year from 1940 through 1959. Increasing capital values in agriculture, exclusive of net investments in farm assets,[2] averaged nearly $1,000 per farm per year

[1] The only other published work along this line is a paper by Dale E. Hathaway, "Agriculture and the Business Cycle." See pp. 55–6 of "Policy for Commercial Agriculture, its Relation to Economic Growth and Stability," papers submitted by panelists appearing before the Subcommittee on Agricultural Policy of the Joint Economic Committee, Nov. 22, 1957, 85th Congress, 1st Session, Joint Committee Print.

[2] Net investment in farm dwellings, service buildings, and other structures is excluded. However, William H. Scofield has pointed out to the author that there has been some increase in total land in farms since 1940, and that clearance, drainage, and other forms of investment in land as distinct from structures have also been common. To this extent, the capital gains and losses of table 1 are not entirely net of farm investment.

TABLE 1.—*Farm capital gains in relation to farm income, 1940–59*

Year	Average net income of farm operators per farm [1]	Average capital gain or loss (–) per farm: Amount [2]	Average capital gain or loss (–) per farm: Percentage of average net income
	Dollars	*Dollars*	*Percent*
1940	720	125	17
1941	1, 044	850	81
1942	1, 600	1, 300	81
1943	1, 942	1, 300	67
1944	1, 967	1, 200	61
1945	2, 080	1, 150	55
1946	2, 574	1, 725	67
1947	2, 648	1, 775	67
1948	3, 065	150	5
1949	2, 259	–650	–29
1950	2, 479	2, 850	115
1951	2, 951	2, 200	75
1952	2, 829	–1, 100	–39
1953	2, 502	–1, 250	–50
1954	2, 440	600	25
1955	2, 313	400	17
1956	2, 338	1, 700	73
1957	2, 426	1, 900	78
1958	2, 990	2, 750	92
1959 [3]	2, 547	875	34
Average 1940–59	2, 286	993	43

[1] From page 41 of the July 1959 Farm Income Situation. Includes the value of changes in farm inventories.
[2] From table 2.
[3] Preliminary.

over the last 20 years. The annual average of farm operators' net income per farm, including inventory changes, was $2,286. Thus, capital gains in agriculture, realized and unrealized, have averaged 43 percent as large as total net income from farming operations.

There were, on the average, some capital gains in farming in 17 of the last 20 years. Only in 1949, 1952, and 1953 were there declines in the average values of total farm assets after subtracting net investments. The average farm capital gain in 1950, the year of the Korean outbreak, exceeded the average net farm income in that year by 15 percent. Another year of unusually large capital gains in farming was 1958, when the average farm had a net appreciation in its capital value of approximately $2,750, chiefly because of higher values of farm real estate. This average capital gain failed to exceed the 1958 average net income per farm only because the latter was the second highest on record.

Note that the averages of table 1 are for all census farms, including part-time, residential, and sharecropper farms. Capital gains on farms of commercial size undoubtedly have averaged much larger.

Some Practical Considerations

Net income and capital gains or losses are not added together in table 1 because they are not entirely comparable magnitudes. The net income of column 1 is "realized" income except for the value of changes in crop and livestock inventories. If inventory changes were omitted, the averages of exclusively realized net income would not differ much from those shown. On the other hand, the average capital gain or loss in the second column of the table represents a mixture of realized and unrealized, chiefly the latter. A farmer cannot realize his capital gains unless he sells out and retires or goes into some other buiness. He then realizes a capital gain for the period during which he has had the farm, not just the year previous to sale.

Relatively few farms change hands each year,[3] so that the bulk of farm capital gains or losses are of the unrealized variety. They are sometimes called "paper profits" because, if real estate and other asset values should decline, those profits could disappear in short order.

Another difference between the two columns of table 1 is that net income is for farm operators exclusively, whereas capital gains and losses, whether realized or unrealized, accrue to the owner of the assets. The percentage of owner operators rose considerably in the last 20 years, and the relative number of tenant operators declined. Since many of the changes in asset values were associated with changes in real estate values, a variable but significant fraction of farm capital gains and losses accrued to farm landlords instead of farm operators.

Thus, the second column of table 1 shows the average capital gain or loss that would have been realized in each of the last 20 years if all farms, with their machinery, livestock and other assets, had been sold regularly each year at the end of

[3] Voluntary transfers over the last 20 years reached a high of 6 percent of all farms in 1946. The low point was 3 percent in 1953.

the year. This concept is not one that permits the addition of capital gains to net income of farm operators. Yet it should help considerably in appraising the significance of capital gains and losses to farmers. A man who bought a farm on January 1, 1940, and sold it on December 31, 1959, would have realized a very substantial capital gain. One who bought a farm 20 years ago and still holds it does not have the cash value in his hands or in the bank ready for immediate disposal, but he has certainly not suffered from rising farm asset values.[4] The averages of table 1 represent an effort to indicate something with respect to the impact of capital gains and losses on the overall economic status of farmers as a group.

Some Theoretical Considerations

Capital gains and losses, whether realized or not, are usually excluded from measures of income. This may be due partly to lack of suitable information, but mainly it is in accordance with theoretical considerations applicable at the national level of income measurement.

In measuring national income, the guiding objective is the coverage of all national output of commodities and services. This coverage should be comprehensive, but without any double counting. Since commodities and services cannot be added together as units, they must be combined in terms of market values and dollar totals. In dealing with sums of money representing income, however, the national income estimator must not lose sight of the fundamental "goods" character of income, and no money should be allowed in the estimates that does not have its counterpart in the production flow of commodities or services. More specifically, what might be called the ebb and flow in value of existing goods is not national income. So capital gains and losses, realized or not, must be excluded. Changes in capital values are important to the owners of capital goods, but obviously they have no bearing on the total amount of commodities and services available to the Nation.

This viewpoint, which is clearly valid for national income, has generally been accepted rather uncritically in other types of income measurement as well. For example, the estimates of farm operators' income have always deliberately excluded the effects of price changes on the value of crop and livestock inventories—one form of unrealized capital gain or loss. Similarly, estimates of total personal income and its distribution by size classes seldom include any allowance for capital gains or losses, although these may have an important bearing on the actual distribution of income among individuals and families.

Recent years have seen some shift in expert opinion on this question, and many economists would now argue that at least the realized capital gains and losses should be taken into account in measuring the size distribution of income. This shift in view was probably accelerated by the increasing prevalence of stock options for corporate executives, plus other tax devices whereby compensation may be viewed as capital gain instead of current income. The special tax treatment of capital gains and losses was originally enacted because they were considered to be entirely different from current income, but the resulting tax incentive has brought about widespread tax avoidance which calls in question the original premise.

In other words, the income of one person—the flow of commodities and services which that person consumes or saves—obviously will be increased by a realized capital gain and decreased by a realized capital loss; so there is every reason to include such gains and losses in estimates of the income of single persons or families. Should this line of reasoning also apply to groups of individuals and families—for example, a group as large as all farm operators?

Further consideration of this question indicates that it is not the size of the group so much as its degree of self-containment that matters. If a family could consume only what it has itself produced, then capital gains and losses would be of no significance. But for an individual in an exchange economy, a realized capital gain is a clear addition to his purchasing power, and a realized capital loss is an obvious reduction in purchasing power.

[4] This statement is true only on the assumption that pecuniary gain is the farmer's primary motivating force. If other considerations are uppermost in his mind—as, for example, the need to remain in farming as a desirable way of life—he may actually suffer from appreciation in the value of his farm. Frederick V. Waugh and Jean L. Pennock have both reminded the author that some farmers in suburban fringe areas around large cities have been driven from their farms by increased taxes and other costs associated with rising land values.

TABLE 2.—*Gross and net change in value of farm assets, total and per farm, 1940–59*

Year	Total assets of agriculture, Jan. 1[1] (1)	Gross change in value of assets during year[2] (2)	Investment in farm assets during year[3] (3)	Net change in value of assets (due to price changes)[4] (4)	Number of farms (5)	Average capital gain or loss (—) per farm[5] (6)
	Billions of dollars	*Billions of dollars*	*Billions of dollars*	*Billions of dollars*	*Millions*	*Dollars*
1940	53.0	2.1	1.3	0.8	6.4	125
1941	55.1	7.4	2.0	5.4	6.3	850
1942	62.5	10.8	2.8	8.0	6.2	1,300
1943	73.3	10.5	2.4	8.1	6.1	1,300
1944	83.8	9.3	2.1	7.2	6.0	1,200
1945	93.1	8.9	2.0	6.9	6.0	1,150
1946	102.0	11.9	1.7	10.2	5.9	1,725
1947	113.9	11.3	.8	10.5	5.9	1,775
1948	125.2	6.9	6.1	.8	5.8	150
1949	132.1	−1.3	2.4	−3.7	5.7	−650
1950	130.8	18.8	2.8	16.0	5.6	2,850
1951	149.6	16.0	3.8	12.2	5.5	2,200
1952	165.6	−2.7	3.4	−6.1	5.4	−1,100
1953	162.9	−3.2	3.4	−6.6	5.3	−1,250
1954	159.7	5.0	2.0	3.0	5.2	600
1955	164.7	3.6	1.4	2.2	5.1	400
1956	168.3	8.1	−.4	8.5	5.0	1,700
1957	176.4	10.0	.7	9.3	4.9	1,900
1958	186.4	16.7	3.8	12.9	4.7	2,750
1959[6]	203.1	5.1	1.1	4.0	4.6	875
1960[6]	208.2					

[1] From The Balance Sheet of Agriculture, 1959.
[2] Difference between successive totals in column 1.
[3] From table 3.
[4] Column 2 minus column 3.
[5] Column 4 divided by column 5.
[6] Preliminary.

Even the Nation as a whole is not entirely self-contained. But it is so nearly so that capital gains and losses may be safely ignored. Are farmers as a group so self-contained that farm capital gains and losses may also be ignored? Probably they were at one time, but not any more.

Since farm income is often used in comparisons with nonfarm income, perhaps the more appropriate question is, May capital gains and losses be ignored for farmers and nonfarmers alike on the assumption that they are about equal on the average? There is serious doubt as to the validity of this assumption. Nonfarm capital gains have certainly been much larger in the aggregate than farm capital gains in the last 20 years. Whether they have been larger in terms of averages per capita or per family is not known. But one important fact is known: Farm capital gains are much more widely distributed among farmers than are nonfarm capital gains among nonfarmers. This fact alone is probably sufficient justification for this study.

There is reason, therefore, to include realized capital gains and losses with income. A realized capital gain is just as "good" as ordinary income to its recipient—and it is a great deal better than ordinary income for families in the upper income brackets.

The case for counting unrealized capital gains and losses is less obvious but perhaps no less valid. All property values in an exchange economy can be turned into current income at the owner's option. The value of property is merely the present value of the goods which that property is expected to produce in the future. A self-contained group can obtain these goods only by waiting until they mature. But any individual in an exchange economy can obtain the current discounted equivalent of these goods any time he chooses to liquidate his property.

Thus, for any farm operator, the whole of his assets might well be added to his current income to indicate his purchasing power or "control" over commodities and services. Any individual farmer

TABLE 3.—*Net investment in farm assets, by type of asset, 1940–59*

Year	Real estate [1]	Livestock [2]	Machinery and motor vehicles [3]	Crops stored on and off farms [4]	Household furnishings and equipment [3]	Financial assets [5]	Total
	Billions of dollars	*Billions of dollars*	*Billions of dollars*	*Billions of dollars*	*Billions of dollars*	*Billions of dollars*	*Billions of dollars*
1940	(6)	0.1	0.1	0.5	(6)	0.6	1.3
1941	(6)	.3	.4	.3	.2	.8	2.0
1942	−.1	.6	−.2	.6	(6)	1.9	2.8
1943	−.1	.4	−.5	−.7	−.1	3.4	2.4
1944	−.1	−.6	.1	.2	−.1	2.6	2.1
1945	−.1	−.2	.3	−.5	(6)	2.5	2.0
1946	.5	−.5	.3	.2	.3	.9	1.7
1947	.6	−.6	1.1	−1.0	.6	.1	.8
1948	.8	−.1	1.7	3.0	.6	.1	6.1
1949	.7	.2	1.8	−.6	.5	−.2	2.4
1950	.8	.6	1.3	−.8	.7	.2	2.8
1951	.7	1.0	1.1	(6)	.5	.5	3.8
1952	1.0	.6	.2	1.0	.5	.1	3.4
1953	.9	−.1	.7	1.2	.4	.3	3.4
1954	.7	.3	(6)	.1	.4	.5	2.0
1955	.6	.1	−.1	−.1	.4	.5	1.4
1956	.6	−.3	−.6	−.5	.4	(6)	−.4
1957	.5	−.1	−.5	.4	.2	.2	.7
1958	.3	.7	.1	1.7	.2	.8	3.8
1959 [7]	.6	.9	.1	−1.1	.2	.4	1.1

[1] Capital expenditures less depreciation and accidental damage of farm dwellings, service buildings, and other structures. There are no estimates of investment in land as distinct from structures.
[2] Value of changes in numbers of livestock on farms.
[3] Expenditures less depreciation.
[4] CCC loans less redemption and deliveries plus the value of changes in farm inventories of crops not under loan.
[5] Change during year in total of farm financial assets.
[6] Less than .05 billion dollars.
[7] Preliminary.

can cash in on an increase in farm asset values at any time he chooses. The obvious fact that all farmers could not do this at the same time is not a valid objection.

Methods of Estimation

Averages per farm are given in table 1, and figure 1 provides a convenient summary of the aggregates from which they were derived. Table 2, starting with the total assets of agriculture in column 1, shows the steps necessary to derive the average annual capital gain or loss in column 6. Table 3 gives annual net investment in various types of farm assets. The totals of table 3 are shown again in one of the steps of table 2 (col. 3), and are cumulated over time in one segment of the chart.

The top line in figure 1 represents the total value of farm assets as shown in The Balance Sheet of Agriculture. It is worth noting, however, that the data on farm debt and "proprietors' equity," so prominent in the regular balance sheet tables, have no place in the present calculations. An increase in farm debt is an offset to saving or investment, not to higher land and other asset values. In fact, if an increase in debt permits the acquisition of additional capital assets—which may increase in value—then the greater the debt the better from the farm owner's standpoint.

As shown in figure 1, the value of farm assets has risen almost continuously throughout the last 20 years. Total assets of agriculture—value of land and buildings, machinery and motor vehicles, crop and livestock inventories, household equipment, and financial assets—increased from $53 billion on January 1, 1940, to more than $208 billion on January 1, 1960. This was almost a fourfold increase. Approximately 30 percent of the increase in total farm assets resulted from investment by farmers in the various types of farm capital assets, in excess of depreciation or deple-

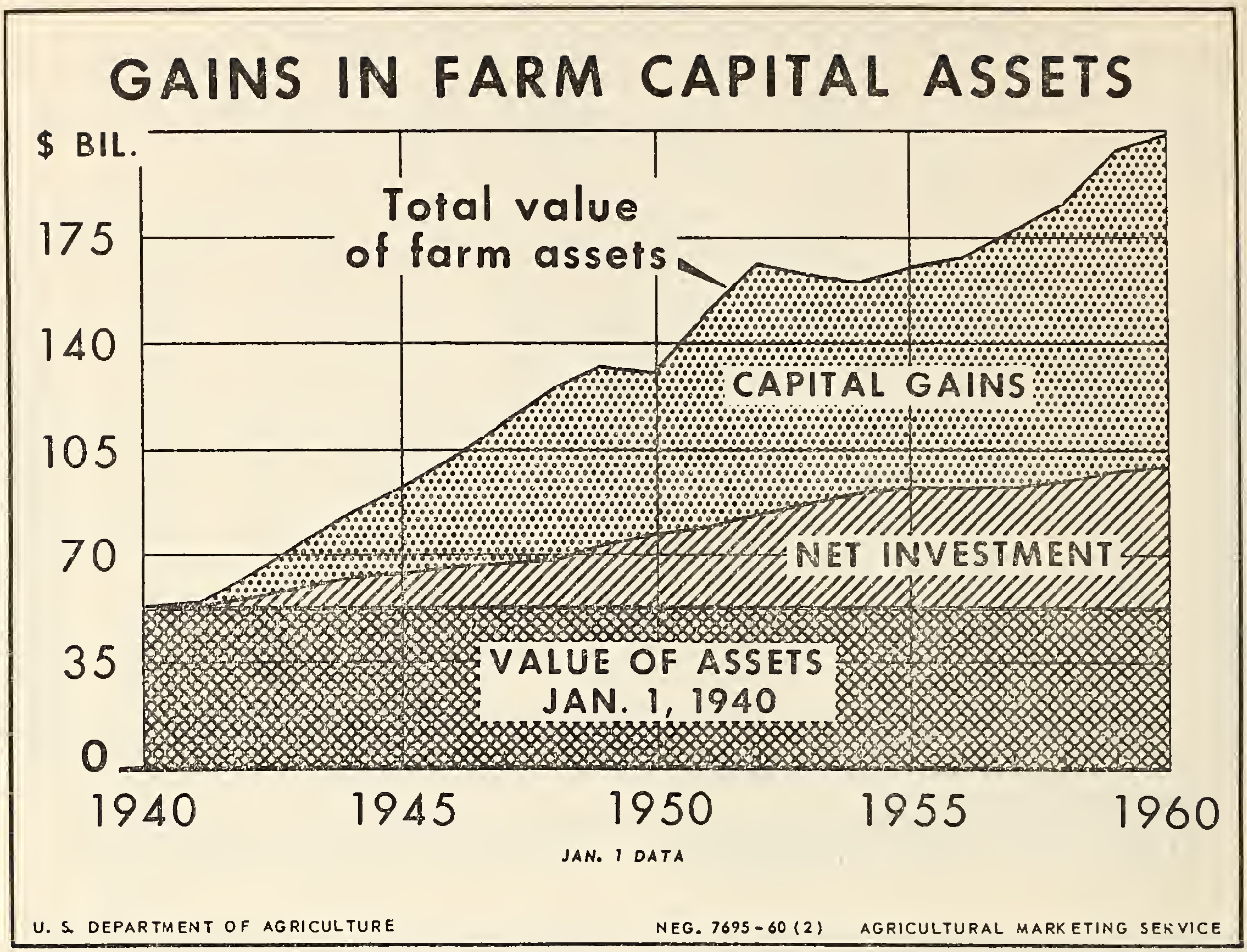

Figure 1.

tion. The remaining 70 percent represent capital gains to the owners.

The aggregate increase in value of farm assets from 1940 through 1959, net of farm investment, was $109.6 billion, or an average of $5½ billion each year. Higher values of farm real estate have been most important, accounting for about 80 percent of all farm capital gains in the last 20 years.

The averages of table 1 could not be derived directly from the totals shown in figure 1. With a 28-percent decline in number of farms since 1940, the average capital gain or loss had to be computed separately for each year. Otherwise, capital gains and farm consolidations would have been hopelessly confused. These separate annual calculations are carried out in table 2.

Table 3, which shows net farm investment by type of asset, is merely one step in the procedure for deriving farm capital gains and losses. However, it may have some interest in its own right, because the totals in the last column are new. Total net investment has varied to some extent with changes in the size of total net farm income. The largest annual total of net investment in the last 20 years was $6.1 billion in 1948, when total net farm income was at an all-time record. On the other hand, the only year in which net investment was a minus quantity was 1956, which was also the postwar low in total net income.

Measurement of Enterprise Variability by the Variate Difference Method

By Gerald W. Dean and Harold O. Carter

Much has been written concerning the importance of risk and uncertainty on decision making. However, research results employing static theory are seldom modified by risk and uncertainty considerations to provide more realistic recommendations to farmers and others making decisions under imperfect knowledge. Too often, for example, farm plans derived by budgeting or linear programming are unqualifiedly recommended as "optimum" because they provide maximum profits under average or "normal" prices and yields. To make such results more meaningful, the farmer also needs some estimate of the risk or uncertainty associated with the plans. Ordinarily, the farmer's view of this uncertainty is highly subjective since his past experiences are often limited (that is, in the case of new farmers) or based on a "biased" sample of years. Thus, farmers need a more objective measurement of the uncertainty or variability associated with various enterprises and combinations of enterprises. Our contribution concerning this problem is published in the Giannini Foundation Paper series. The authors offer acknowledgment to C. O. McCorkle, Jr., G. M. Kuznets, and G. Tintner for helpful suggestions in various phases of the study and preparation of the manuscript.

THE purpose of this paper is to indicate the possibilities, advantages, and limitations of the variate difference method for estimating variability measures for individual crops and cropping combinations. Variability measures of this type can be used effectively by teaching and extension personnel. In addition, such information may be incorporated by researchers into certain linear programming problems.[1] We shall argue that the variate difference method[2] may more nearly isolate the truly "random" or "unpredictable" component of total variability than alternative methods and hence provide a more relevant measure of risk or uncertainty.[3] Finally, empirical applications of the variate difference method for estimating crop production variability in California are briefly considered.

Measurement of Variability

In the preceding paragraph, the terms "risk" and "uncertainty" are used loosely to characterize the general framework of imperfect knowledge within which decision makers operate. More precisely, following Knight,[4] risk situations are

[1] The variance and covariance measures derived by the method investigated in this paper appear to be applicable in risk or stochastic linear programming studies. The authors are currently investigating this possibility in more detail. For previous work in this area, see: Babbar, M. M., "Distribution of Solutions of a Set of Linear Equations," Jour. Amer. Statis. Assoc., Vol. 50, 1955, p. 854; Tintner, G., "Stochastic Linear Programming," Second Symposium on Linear Programming, U.S. Bureau of Standards, Washington, D.C., 1955, p. 197; Freund, R. J., "The Introduction of Risk into a Programming Model," Econometrica, Vol. 24, 1953, p. 253; Heady, E. O. and Candler, Wilfred, *Linear Programming Methods*, The Iowa State College Press, Ames, Iowa, 1958, p. 554.

[2] Tintner, Gerhard, *The Variate Difference Method*, Bloomington, Ind.: Principia Press, Inc., 1940 (Cowles Commission for Research in Economics Monograph No. 5), 175 pp.

[3] Heady, Brown, Botts, and Kling have derived similar measures of variability with different methods for both crops and livestock production based on time series data. See for example: Heady, E. O., Kehrberg, E. W., and Jebe, E. H., *Economic Instability and Choices Involving Income and Risk in Primary or Crop Production*, Iowa Agr. Expt. Sta. Res. Bul. 404, 1954; Brown, W. G. and Heady, E. O., *Economic Instability and Choices Involving Income and Risk in Livestock and Poultry Production*, Iowa Agr. Expt. Sta. Res. Bul. 431, 1955; Botts, R. R., *Variability of Cotton Yields*, U.S. Bur. Agr. Econ. August, 1952 (Mimeo); Botts, R. R. and Barber, E. L., *Variability of Corn Yields*, U.S. Bur. Agr. Econ., July 1952, (Mimeo); and Kling, William, "Determination of Relative Risks Involved in Growing Truck Crops," Jour. Farm Econ. Vol. 24, August, 1942, No. 3.

[4] Knight, Frank H., *Risk, Uncertainty and Profit*, Boston: Houghton Mifflin Co., 1921.

those in which parameters (such as the mean and variance) of the probability distribution of outcomes can be established empirically; uncertainty situations are those in which such parameters cannot be objectively established. Thus, any study that attempts to estimate empirically "measures of variability" falls more nearly in the classical *risk* setting. In fact, by providing objective measures of the variability of outcomes, the researcher is attempting to transfer decision makers from an *uncertainty* to a *risk* setting. Thus, rather than relying on a "subjective guess," the decision-maker receives quantitative estimates of variability to guide his actions.

Variability in agriculture stems from the fact that crop yields, livestock gains per feed unit, prices, costs, and incomes are influenced by many variables—some in a systematic or rather "predictable" fashion and others in an unpredictable or "random" manner, at least when viewed *ex ante*. Imperfect knowledge of the future stems primarily from the random or unpredictable component. While, by definition, the value of a random component in any one year cannot be predicted, parameters (such as the variance) of the distribution of the random component might be estimated as guides in decision making. However, a difficult question arises: From the standpoint of the individual farmer, what portion of total variability is really unpredictable or random and what portion is predictable? [5]

The most naive assumption is that any deviation from the long-run mean is a random or unpredictable event in the eyes of the farmer. Such a procedure essentially represents a "no knowledge" situation. More realistically, farmers probably recognize certain long-run physical and economic trends over time, such as the advancing level of technology, inflation, and price cycles. For example, farmers planning crop production for the year ahead are more likely to view the random element of yields or prices as a deviation from the "current level" rather than as a deviation from the long-run mean.[6]

Several different empirical procedures are available for determining the exact current level of the time series (and hence for determining the deviations from this current level). One familiar technique is to approximate the current level of the time series by a fitted trend line, then to assume that deviations from trend represent the random component.[7] A second method is to assume that the current level is identical with the observation in the previous year. In this case, the random element is identical with first differences of the data.[8] A third procedure might be to approximate the current level by a moving average, then to assume that deviations from this moving average constitute the random element. A price series might be deflated by some general price index to arrive at "real" values of the series, then the deviations from the long-run mean of the deflated series would be assumed to represent the random element.

Arguments for and against each of these procedures might be advanced. But the one that seems to the authors to be most reasonable is the first method of trend removal. Even this procedure is based on the limiting assumption that the systematic component of the time series (that is, the general price level, technological trend, and so on) can be characterized by linear, polynomial, or other types of mathematical functions. The authors prefer a statistical method that does not depend on rigid functions which may be difficult to defend on economic grounds. The variate difference method seems to meet this objection.

The fundamental assumption of the variate difference method is that every economic time series consists essentially of two additive parts. The first part is the mathematical expectation or systematic component of the time series in which consecutive observations are positively correlated with each other. This does not imply that the procedure is restricted to series showing a positive trend, that is, a negatively sloped line also produces positively correlated consecutive observations. However, the method is inappropriate for

[5] It is recognized that certain fluctuations which might be classed as unpredictable or "random" to the individual farmer could in fact be "explained" by appropriate aggregate supply and price analysis.

[6] By "current" level is meant the general level at the time the decision is made, rather than the level in 1959. Thus, with respect to any past year, the "current" level refers to the general level prevailing in that particular year.

[7] Crop yields have been handled in this way by Heady, et al., *op. cit.*, p. 627.

[8] See: Kling, *op. cit.*, p. 695.

excessively "zigzag" series. The second part is the random or unpredictable component in which consecutive items are assumed not to be autocorrelated.[9] The variate difference method is appropriate for separating out the random portion of time series because it avoids unnecessary assumptions about the functional character of the systematic component. It is assumed that the smooth part of the time series (the systematic component) can be approximated by polynomials of the variable time which otherwise need not be specified. A well-known theorem regarding a polynomial of degree m is that its m-th finite difference is constant and its m+1, m+2, . . . finite differences vanish. However, the random component cannot be reduced by finite differencing since it is not ordered in time (that is, it cannot be approximated by a smooth function). Thus, the method is designed to eliminate the systematic component by successive finite differencing, leaving an estimate of the random element.

Estimating Individual Enterprise Variability by Variate Difference Method

Using the variate difference method, the variance of a time series can be "split up" into two parts one of which comes from the mathematical expectation and the second of which is the variance of the random component. As indicated above, interest is in this latter quantity as an estimate of enterprise variability. The method consists of calculating variances of the original series and of the series of successive finite differenes. If a finite difference of the order k_0 can be found such that the variance of the k_0^{th} difference is equal to the variance of the $(k_0+1)^{th}$ difference and equal to that of the $(k_0+2)^{th}$ difference, and so on, it is reasonable to assume that the mathematical expectation has been eliminated to a reasonable degree by taking k_0 differences.[10] The difference between the variances of two successive series of finite differences is compared with its standard error in order to decide when the variances are approximately equal. If the difference is smaller than about three times its standard error, it is reasonably certain that, from a probability viewpoint the finite differencing has been carried sufficiently far to have eliminated the nonrandom element; remaining is an estimate of the variance of the random component of the time series.

As an example of the method, table 1 summarizes the computations used in estimating the variance of the random component of early fall lettuce yields in California for the years 1918–57. The question is: Beginning with which difference is it reasonably certain that the nonrandom element has been eliminated, leaving an estimate of the random variance? Table 1 indicates that the variance does not stabilize until the second difference, as shown by the standard error ratios of 5.44, 4.23, and 1.09. Therefore, 224.72 is taken as the estimate of the variance of the random component.

Empirical Results

Table 2 indicates the relative variability in yield, price, and gross income of selected California crops using the variate difference method.[11] The variability coefficient (equation 1) expresses the square root of the random variance (standard deviation of the random component) as a percentage of the 1953–57 mean of the series;[12]

$$(1)\ \text{Variability coefficient} = \frac{\sqrt{\text{random variance}}}{\text{1953–57 mean}} \times 100,$$

variability relative to recent levels seems

[9] It should be emphasized that the variate difference method is only applicable if there is no auto-correlation in the random element. See Tintner, Gerhard, *Econometrics.* John Wiley and Sons, Inc., New York, 1952, pp. 312–314.

[10] Tintner, *op. cit.*, p. 33.

[11] While net income variability is of ultimate interest to farmers, lack of adequate cost data prevented its derivation for all crops. Net income variability is used, however, where crop combinations are considered later in the paper. Only 18 crops are presented in table 2. For a more detailed discussion of (a) price, yield, and gross income variance of 57 California crops, and (b) net income variability of selected cropping systems, see Carter, H. O. and Dean, G. W., *Relationships Between Income Stability and Income Levels for Principal California Crops and Cropping Systems*, Calif. Agr. Expt. Sta. Bul. (forthcoming).

[12] State annual average data for 1918–57 comprise the time series used. Data limitations are discussed in more detail later.

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TABLE 1.—*Calculation of the variance of early fall lettuce yields in California, 1918–57, using the variate difference method*

Order of difference	Unadjusted variance of the k th difference [1]	Adjusted variance of the k th difference [2]	Difference between adjusted variances	H_{kN}- (N=40) [3]	Standard error of difference between variances	Standard error ratio [4]
(1)	(2)	(3)	(4)	(5)	(6)	(7)
k	$V'_k=\frac{\Sigma\Delta_k^2}{N-k}$ $(N=40)$	$V_k=V'_k\div{}_{2k}C_k$	V_k-V_{k+1}	----------	${}^{S}V_k-V_{k+1}=V_k\div H_{kn}$ $(N=40)$	$R_k^{\circ}=\frac{V_k-V_{k+1}}{{}^{S}V_k-V_{k+1}}$
		Col. (2) $\div{}_{2k}C_k$	------------	----------	Col. (3) $\div$ Col. (5)	Col. (4) $\div$ Col. (6)
0--------	2, 890. 18	2, 890. 18	2, 545. 99	6. 170	468. 42	5. 44
1--------	688. 38	344. 19	119. 47	12. 190	28. 24	4. 23
2--------	1, 348. 32	224. 72	15. 14	16. 106	13. 95	1. 09
3--------	4, 191. 60	209. 58	. 99	18. 860	11. 11	. 089
4--------	14, 601. 30	208. 59	1. 09	20. 795	10. 03	. 109
5--------	52, 290. 00	207. 50				

[1] Calculated as the sum of squares of the series of k th differences, divided by $N-k$.
[2] Further explanation available in Tintner, *op. cit.* p. 40–41.
[3] From table 20, Tintner, *op. cit.* p. 57–59.
[4] This test is based on the normal approximation.

most meaningful for comparisons between crops.[13] The empirical results emphasize the extremely wide range of variability resulting from the random elements associated with the diverse crops produced in California. Yield variability ranges from 2 percent for early fall tomatoes to 31 percent for olives; price variability ranges from 4 percent for wheat to 43 percent for early potatoes; gross income variability ranges from 7 percent for sugar beets to 36 percent for olives. High variability for many crops is even more striking in that the variability coefficients are based on the "random variance" which, in general, is considerably smaller than "total variance." Furthermore, use of aggregate data throughout (county and State data) probably causes an underestimate of variability facing individual farmers. (See appendix.) The results provide at least one reason for the development of a highly commercialized California agriculture. Many of the high-variability crops require highly technical specialized knowledge and, hence, tend to be produced by specialty growers. Only a producer with strong financial support can bear the risks associated with specialization in these high variability crops.

Consider the simplest case of combining two enterprises: Under the first method of diversification, total income variance (σ_T^2) is given by equation (2) in which σ_A^2 is the income variance

(2) $$\sigma_T^2=\sigma_A^2+\sigma_B^2+2r_{AB}\sigma_A\sigma_B$$

of enterprise A, σ_B^2 is the income variance of enterprise B and r_{AB} is the correlation between the incomes of enterprises A and B.[15] Under the second method of diversification, total income variance (σ_T^2) is given by equation (3) in which q is

(3) $$\sigma_T^2=q^2\sigma_A^2+(1-q)^2\sigma_B^2+2q(1-q)r_{AB}\sigma_A\sigma_B$$

the proportion of resources devoted to A, $1-q$ is the proportion of resources devoted to B and the

[13] The question arises as to whether the random variance is homogeneous with respect to time. As a "rough" test, the random variances were computed for the two subperiods 1918–37 and 1938–57. Where no statistical difference was detected between these variances (as indicated by Bartlett's test of homogeneity of variance) the crop variance was based on the 1918–57 series; where the variance changed significantly over time, the variance based on the most recent 20-year subperiod was taken as the best estimate of future variance.

[15] Total income equals income from A plus income from B or: $T=A+B$

By definition: $\text{Var}\ (T)=E[(A+B)-E(A+B)]^2$
$=\sigma_A^2+\sigma_B^2+2r_{AB}\sigma_A\sigma_B$

For additional detail on derivation see, for example: Anderson, R. L., and Bancroft, T. A., *Statistical Theory in Research*, New York, New York: McGraw-Hill Book Co., Inc., 1952, p. 33.

Table 2.—*Relative variability of yield, price, and gross income of selected California crops*

Crop	Variability coefficients [1]		
	Yield	Price	Gross income
	Percent	*Percent*	*Percent*
Field crops:			
Alfalfa	3	11	15
Barley	5	10	8
Sugar beets	6	6	7
Potatoes, early	6	43	35
Wheat	7	4	8
Rice	10	10	10
Vegetables:			
Tomatoes, early fall	2	13	10
Tomatoes, processed	5	7	8
Onions, late summer	6	37	35
Lettuce, summer	9	18	31
Lettuce, winter	12	19	24
Cantaloups, spring	16	17	26
Fruits and nuts:			
Grapefruit	5	11	5
Peaches, clingstone	10	15	19
Grapes	10	31	29
Oranges, valencia	17	20	10
Almonds	19	21	17
Olives	31	27	36

[1] Variability coefficient $=\dfrac{\sqrt{\text{random variance}}}{\text{1953–1957 mean}}\times 100$

other symbols are as defined above.[16] To estimate total variance in either case, estimates are needed of (1) the income variances of individual enterprises and (2) the correlation of incomes between enterprises.

As pointed out in the previous section, the variate difference method provides an estimate of the income variances of individual enterprises (that is, the variance of the random component of incomes). To be consistent with the concept of dealing with only the random element, the correlation coefficient should measure the association between the random components of the incomes of the two enterprises. Tintner[17] summarizes the logic and procedure for obtaining the correlation between the random elements of two time series. The approach is similar to that employed in obtaining the variance of a random component of a time series. Again, it is assumed that each series consists of a nonrandom element or mathematical expectation and a random element. The product moment and correlation coefficients between the two series are computed for each of the successive differences. This procedure is continued until the product moments (p_k) of the successive differences stabilize. If the nonrandom element has been eliminated in the $k_o{}^{th}$ difference, the following relationship holds:

$$p_{k_o}=p_{k_{o+1}}=p_{k_{o+2}}=\cdots \tag{4}$$

If the difference between the product moments of two successive differences is smaller than about three times its standard error, it is reasonable to assume that the nonrandom elements have been eliminated, leaving an estimate of the product moment of the random elements.

Table 3 summarizes the computations involved in obtaining an estimate of the correlation coefficient between tomatoes and sugar beets in Yolo County, Calif. Using the standard error ratio criterion, the correlation between the first differences (0.05) is taken as the estimate of the correlation between the random elements of the two series. This correlation (0.05) is considerably less than that between the original two series (0.82). While both series exhibit strong upward trends, there is little correlation between the first differences.

Table 4 provides a summary of net income correlations (based on county yields and costs and State prices) as computed by the variate difference method between selected pairs of crops grown in several major farming areas of California. In general, the correlations obtained by the variate difference method are much lower than those between the original series. The actual net incomes of crops tend to be highly correlated because the major economic influences (inflation, price cycles, wars, level of technology, and so on), affect most enterprises similarily. The question is whether the correlation between (1) the original series or (2) the random elements is more meaningful for decision making. In the "no knowledge" case mentioned previously (p. 44), in which all deviations from the long-run mean are considered random or unpredictable, the relevant correlation is between the original series. As derivation of

[16] Thus, $T=qA+(1-q)B$

$$\operatorname{Var}(T)=E\{qA+(1-q)B-E[qA+(1-q)B]\}^2$$
$$=q^2\sigma_A{}^2+(1-q)^2\sigma_B{}^2+2q(1-q)r_{AB}\sigma_A\sigma_B$$

Likewise, see Anderson, R. L., and Bancroft, T. A., *Ibid.*, p. 33.

[17] Tintner, *op. cit.*, p. 117–129.

TABLE 3.—*Calculation of the net income correlation between tomatoes and sugar beets in Yolo County, Calif., 1938–57, using the variate difference method*

Order of difference	Adjusted product moment of the *kth* differences [1]	Difference between adjusted product moments	Standard error of difference between adjusted product moments [2]	Standard error ratio [3]	Random variance of sugar beet net income [4]	Random variance of tomato net income [4]	Correlation coefficient between random components
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
k	$P_k=\frac{\Sigma^{(k)}XY}{(N-k)_{2k}C_k}$ ($N=20$)	P_k-P_{k+1}	${}^{S}P_k-P_{k+1}=\frac{\sqrt{L_k}}{H_{kN}}$ ($N=20$)	$\hat{R}_k^2=\frac{P_k-P_{k+1}}{{}^{S}P_k-P_{k+1}}$	$V_k(X)$	$V_k(Y)$	$r_k=\frac{P_k}{\sqrt{V_k(X)V_k(Y)}}$
				Col. (3) ÷ Col. (4)	------	------	Col. (2) ÷ $\sqrt{\text{Col. (6)}\times\text{Col. (7)}}$
0	663. 31	658. 23	173. 53	3. 79	1, 354. 76	481. 56	0. 82
1	5. 08	7. 20	9. 24	. 78	304. 58	34. 80	. 05
2	−2. 12	−3. 04	6. 25	−. 49	287. 80	25. 87	−. 02
3	. 92	------	--------------	--------	293. 86	24. 23	. 01

[1] Calculated from the sum of cross products of the k^{th} differences of the two series divided $(N-k)\ {}_{2k}C_k$. X and Y denote sugar beet and tomato net incomes per acre, respectively.
[2] See Tintner, *op. cit.*, p. 119–120 for definitions and explanations of L_k and H_{kN}.
[3] This test is based on the normal approximation.
[4] Computed as in table 1.

the variance of an enterprise combination requires estimates of both individual enterprise variances and the covariance between enterprises, mathematical consistency requires both variances and covariances to be based either on the original series or on the random elements of the series. That is, it is mathematically inconsistent to combine random variances and "actual" correlations, or vice versa. In practice, however, farmers are generally aware of long-run trends and hence are constantly revising plans in light of new technology and changing demands and price relationships. For this group, the correlations of the random elements seem to be more meaningful. At a given point in time, the farmer is aware of the general relative levels of income from various enterprises. What he desires is a measure of the relationship between random year-to-year changes in net income for various crops. For example, if two enterprises have a strong negative correlation between their random components, they might make an excellent diversification prospect for a particular year, even though the correlation between the original series is strongly positive.

Empirical Results

In practice, most cropping systems in California include more than two crops. Generalizing the two-crop case, it can be shown that the total variance equation for redistributing resources among n enterprises is:

$$\sigma_T^2=\sum_{i=1}^{n}q_i^2\sigma_i^2+2\sum_{\substack{i,j=1\\ i>j}}^{n}q_iq_jr_{ij}\sigma_i\sigma_j \tag{5}$$

in which q_i $(i=1, \ldots . n)$ is the proportion of resources devoted to the i^{th} enterprise and $\Sigma q_i=1$. Using this general formula, the total variances were computed for specific common cropping systems in six agricultural areas of California. The standard deviations ($\sqrt{\text{random variances}}$), 1953–57 mean net incomes and variability coefficients of these cropping systems are presented in table 5.[18] Again, county yields and costs and State prices were used. The results in table 5 indicate the wide range in levels and variabilities of incomes within and between areas of California. Extension personnel in farm management and agronomy have indicated considerable interest in utilizing such information on a "practical" level in the State.

[18] For a more complete presentation and interpretation of results, see Carter, H. O. and Dean, G. W., *op. cit.* This publication also develops further relationships between income levels and stability where the proportions of crops in the systems are allowed to vary.

TABLE 4.—*Net income correlation coefficients between selected crop combinations in major farming Areas of California* [1]

Crop combination	Area					
	Northern Sacramento Valley	Yolo	Fresno-Madera	Kings-Tulare Lake	Kern	Imperial Valley
Alfalfa-Cantaloups			0.02			
Alfalfa-Sugar Beets		−0.38	.09		0.45	0.02
Alfalfa-Cotton			−.29	−0.32	−.29	.13
Sugar Beets-Cantaloups			.14			
Cantaloups-Cotton			.14			
Cotton-Sugar Beets			−.10			.13
Barley-Alfalfa		.42		.37	.19	.63
Barley-Cotton				.28	.35	.44
Barley-Sugar Beets		−.04			.24	.14
Potatoes-Alfalfa					.59	
Potatoes-Cotton					.18	
Potatoes-Sugar Beets					−.17	
Potatoes-Barley					.23	
Rice-Wheat	0.40				.31	
Rice-Barley	.43					
Tomatoes (owner-operator)-Alfalfa		.60				
Tomatoes (leased)-Alfalfa		.56				
Tomatoes (owner-operator)-Barley		.16				
Tomatoes (leased)-Barley		.10				
Sugar Beets-Tomatoes (owner-operator)		.01				
Sugar Beets-Tomatoes (leased)		.05				

[1] Computed using the variate difference method. Thus, correlations are between the random components of the pairs of series.

Conclusions

Use of aggregate data force certain limitations on the interpretation of net income variability estimates for individual crops and cropping systems. (See Appendix.) Despite this limitation, variability estimates may provide a fairly good idea of the relative risk or uncertainty of crop alternatives. Finally, the variate difference method provides estimates of variability which, it is argued, have greater relevance to decision making by individual farmers than estimates derived by other commonly used methods.

Aggregation Problems

Data limitations ordinarily force use of aggregate data in estimating the variability of yields, prices, and incomes. Since interest is in variability to the individual farmer, this question arises: Do variability measures derived from aggregate data accurately reflect individual farm variability? Intuitively, some "averaging-out" of individual farm variability might be expected in the compilation of aggregate data. This problem is expected to be most severe with respect to yield variability. However, if interest is in random variability, it is also possible that individual farm yields are not ideal for analysis. For example, individual fluctuations in farm yields depend not only on random influences but also on conscious changes by the farmer in practices, levels of inputs, and so on, from year-to-year. Thus, it is not entirely clear what type of yield data are ideal for this type of investigation. Most researchers, however, probably would prefer variability measures based on individual farm data if available. Unfortunately, individual farm yield information of sufficient historical length for analysis is almost nonexistent. In the California study, for example, county yield and cost data and State prices were used as the only source available.

How serious, then, is the aggregation problem in estimating individual farm yield variability? It can be shown that, under certain assumptions, the bias depends on N (the number of farms comprising the aggregate) and ρ (the correlation between the random components of yields on these

TABLE 5.—*Net income variability comparisons between selected crop combinations in six areas of California (assuming a 560-acre farm)*

Crop combination [1]	Mean net income 1953–57 [2] (1)	Standard deviation [3] (2)	Variability coefficient [4] (3)
	Dollars	*Dollars*	*Percent*
NORTHERN SACRAMENTO VALLEY			
1. R–R–R-B	39,154	10,696	27
2. R–R–R–W	39,715	10,304	26
3. R–R–R–F	34,530	9,990	29
YOLO COUNTY AREA			
1. A–A–A–SB–T–SB	40,891	5,992	15
2. A–A–A–T–SB–B	36,982	6,530	18
3. A–A–A–T(L)–SB–B	29,731	4,872	17
4. A–A–A–SB–B–B	25,172	4,833	25
FRESNO-MADERA AREA			
1. A–A–A–Ca	35,358	15,786	45
2. A–A–A–C–SB	36,943	7,795	21
3. A–A–A–C–C–SB	45,461	10,595	23
4. A–A–A–C–C–Ca	53,284	15,036	28
5. A–A–A–C–SB–Ca	43,764	12,320	28
6. A–A–A–SB	23,862	8,305	35
7. A–A–A–SB–Ca	33,897	13,132	39
KINGS-TULARE LAKE BASIN			
1. A–A–A–C–B	36,361	7,006	19
KERN COUNTY AREA			
1. A–A–A–P–P	54,415	50,523	93
2. A–A–A–C–C–C	68,186	14,011	21
3. A–A–A–SB–C–SB	42,381	11,256	27
4. A–A–A–C–C–P	65,492	22,008	35
5. A–A–A–C–B–P	50,137	21,840	44
6. A–A–A–C–P	57,585	25,833	45
7. A–A–A–SB–B–P	36,842	23,660	64
IMPERIAL VALLEY			
1. A–A–A–C–C–SB	48,681	9,850	20
2. A–A–A–C–B–SB	35,638	7,683	22
3. A–A–A–C–C–C	55,647	12,549	23
4. A–A–A–C–C–B	42,207	9,862	23

[1] Assumes equal proportions of the 560-acre farm devoted to each crop in the crop combination. For example' R–R–R–B refers to 420 acres of rice and 140 acres of barley. Symbols are defined as: A=alfalfa, B=barley, C=cotton' Ca=Cantaloups, SB=sugar beets, R=rice, W=wheat, F=fallow, T=tomatoes (owner handles complete operation) T(L)=tomatoes (owner leases land in return for 17 percent of gross income), and P=potatoes.

[2] Net income is defined for this study as gross income minus variable costs only.

[3] Standard deviation is the square root of the estimated variance for the respective crop combinations as estimated by the variate difference method.

[4] The variability coefficient is the ratio of the standard deviation (col. 2) to the mean net income (col. 1), multiplied by 100.

farms). The yield (Y) on the i^{th} farm in the year t might be written:

(6) $$Y_{it}=\pi_i+\beta_i t+e_{it}$$

in which t=time in years and $i=1, 2 \ldots N$. π and β are parameters and e is a random variable. The usual assumptions are made:

$$E(e_{it})=0 \text{ and } E(e_{it})^2=\sigma_i^2.$$

Averaging over all N farms gives:

(7) $$\bar{Y}_t=\bar{\pi}+\bar{\beta}t+\bar{e}_t.$$

It is assumed that $E(\bar{e}_t)=0$. However, the variance of $\bar{e}_t$ is:

(8) $$\text{Var}(\bar{e}_t)=\frac{1}{N^2}\left(\sum_{i=1}^{N}\sigma_i^2+2\sum_{\substack{i,j=1\\ i>j}}^{N}\rho_{ij}\sigma_i\sigma_j\right)$$

Two assumptions might be made at this point. First is the assumption that all farms in the aggregate considered have a common variance ($\sigma_i^2=\sigma^2$). Certainly a crop grown in widely differing geographic locations and climatic environments might not have a homogeneous variance among all locations. Thus, a single variance estimate based on State averages might not accurately represent the variance for any particular area. Use of aggregate data involving a smaller geographic area (for example, county data) makes this assumption more realistic. The second assumption is that the random components of yields between all possible pairs of farms are correlated to the same extent ($\rho_{ij}=\rho$). Granting these two assumptions, equation (8) may be rewritten as:

(9) $$\text{Var}(\bar{e}_t)=\frac{1}{N^2}[N\sigma^2+N(N-1)\rho\sigma^2]$$
$$=\frac{\sigma^2}{N}[1+(N-1\rho)].$$

If $\rho=1$ (that is, perfect yield correlation of the random components between farms), then Var $(\bar{e}_t)=\sigma^2$. However, if $\rho<1$ (undoubtedly, a more realistic case), the estimated variance varies inversely with the number of farms making up the aggregate. With respect to factor and product prices, the correlation between farms is probably close to one; hence, the number of farms making up the aggregate price and cost series would affect the corresponding variance estimates very little. With respect to yields, however, this bias is probably not negligible and should be recognized in using aggregate data. Despite this limitation, a rough idea of *relative* variabilities of crops can probably be derived from aggregate data.

In addition to aggregation problems, an internal inconsistency exists when time series data are used to first estimate yield and price variability and then gross income and net income variability. For example, gross income per acre is defined as the product of price and yield per acre. Further, yield and price series are each assumed to consist of a systematic and random element as follows:

(10) $$Y_t=\pi+\beta t+e_t \text{ and}$$

(11) $$P_t=\theta+\delta t+\epsilon_t.$$

Y is yield per acre, π and β are parameters, t denotes "time," and e is a random variable. P is price per unit, θ and δ are parameters, and ϵ is a random variable. Accordingly, gross income per acre (GI) in year t would be written as:

(12) $$GI_t=Y_tP_t=\theta\pi+\theta\beta t+\theta e_t+\delta\pi t$$
$$+\delta\beta t^2+\delta t e_t+\pi\epsilon_t+\beta t\epsilon_t+e_t\epsilon_t.$$

It is apparent from the product of error and non-error terms (e.g., $\beta t\epsilon_t$, $\delta t e_t$, and so on) that differencing or trend-fitting methods can never completely eliminate the systematic components from the error terms. Consequently, these procedures provide only an approximation to the random variance for gross income. The same problem appiles to estimating net income variance.

Appendix

Variate Difference Method of Estimating Variability of Cropping Combinations

Diversification of combinations of enterprises often is recommended as a means of lessening income variability. Since diversification principles are discussed elsewhere,[14] only a brief review is necessary here to provide the foundation for an empirical application of the variate difference method. Basically, diversification can be accomplished either by (1) adding sufficient resources to include the new enterprise or enterprises without reducing the size of the present enterprises or by (2) redistributing a constant quantity of resources among more enterprises.

These limitations are not associated exclusively

[14] See for example: Heady, E. O., *Economics of Agricultural Production and Resource Use.* (New York: Prentice Hall, 1952), Chapter 17, Heady, E. O., Kehrberg, E. W. and Jebe, E. H. *op. cit.*, pp. 661–667; and Carter, H. O. and Dean, G. W. *op. cit.*, pp. 33–39.

with the variate difference method but rather with all methods of trend removal. However, one empirical problem relates particularly to the variate difference method: It is sometimes difficult to select the appropriate difference at which the variance of a series or the product moment of two series is stabilized. The standard error ratio criterion is not strictly applicable to "short" time series (small samples); hence, the choice of the random variance or product moment may involve some judgment on the part of the investigator.

A Basis for the Reconsideration of Wastes and Losses in Food Marketing

By Harry Sherr

Many studies have been made of wastes and losses in the marketing of food and of the possibility of their reduction. Some have focused on technological aspects, others on the failure to satisfy consumer needs. This paper uses a fresh approach by stressing the economic aspects of the problem—the costs in basic production resources and alternative costs in marketing resources involved in reducing wastes and losses.

FOOD PRODUCED by farmers in the United States reaches consumers through a vast, complicated, and relatively efficient system of distribution. Wastes and losses occur in the process of preparing and moving the tremendous volume of food through marketing channels, both because food is perishable in varying degree, and because of the separation in space and time between production and consumption. The wastes and losses that do occur represent unintended use of production and marketing resources; to reduce them would require institutional changes or changes in production or in the marketing resources used.

Consideration of the problems of food-marketing wastes and losses needs some reorientation. In the past, the usual approach was characterized by measuring what goes into garbage pails. Emphasis on economic choices between alternative costs is likely to be more meaningful. Accordingly, decisions as to the changes that should be made in production and marketing to minimize wastes and losses might better be based on explicit economic analysis of marketing wastes and losses—including their relative magnitudes, indications of the major economic alternatives involved in reducing them, and consideration of the economic implications of the magnitudes and alternatives.

The basic economic alternative is whether it is less costly to accept wastes and losses or to make use of resources to reduce them. This and later choices among the available alternatives depend on combinations of several economic and technological factors. The choices that are made frequently have important implications for farmers, marketing agencies, and consumers.

In this paper, the several objectives are: To clarify what is meant by wastes and losses in food marketing; to indicate what is known about them; to outline some of the major economic alternatives in reducing wastes and losses; and to discuss some of the economic implications of the choices investigator.

Wastes and Losses in Food Marketing

What Are They?

The interpretation of the phrase "wastes and losses in food marketing" varies among groups of people with differing interests. To *physical scientists*, they represent reductions in quantity or quality of the physical product arising from natural factors inherent in or external to the product, or to mechanical causes such as crushing or bruising. *Economists* view wastes and losses in terms of costs incurred versus alternative costs. More specifically, they view them (1) in macroeconomic terms of total farm and marketing resources [1] which may or may not be used most efficiently, the cost to the community or industry of making or not making changes to reduce wastes and losses, and consumer food needs which may be satisfied in varying degrees; and (2) in microeconomic terms of the operational alternatives available to

[1] Resources are measured by the value of the food commodity and the added value of marketing inputs.

the firm as it seeks to maximize returns and to the consumer as he seeks to maximize satisfactions.

To *businessmen*, wastes and losses represent (1) outlays for plant, machinery, and equipment required to keep wastes and losses at a minimum; (2) an element in the prices they pay or receive for food; and (3) a source of possible loss of consumer goodwill. To *consumers*, marketing wastes and losses of food may result in higher prices than necessary and possible dissatisfaction because of poor quality of the commodity. From the standpoint of *public policy*, the interest in marketing wastes and losses includes the objective of optimum returns from the use of economic resources to provide the domestic population with an adequate diet, in terms of nutrients and palatability.

Why Do They Occur?

Wastes and losses of food in marketing occur chiefly for natural reasons and mainly among the more perishable foods, as the differences in space and time between the functions of production and consumption have continued to widen. Efforts of food marketing firms and Government agencies to reduce wastes and losses, including quality deterioration, have made it possible for many foods to be available in relatively large volume during most of the year throughout the United States.

Wastes and losses occur because food is, or was when harvested, a living form.[2] After food is harvested,[3] destruction from natural causes is hastened. Internally, this occurs because the cells break down and are not replaced with new, healthy cells; the commodity becomes vulnerable to attack from microorganisms, which it was able to withstand before harvest; or it deteriorates because of latent diseases, dehydration, or a combination of causes.

Meat, eggs, milk, and most fresh vegetables are particularly vulnerable, and start deteriorating immediately upon harvest unless the process is (1) halted for an extended period by changing the form of the commodity—by canning, drying, freezing, pickling, salting, smoking, or irradiating—or (2) deterred by controlling temperature, humidity, and other environmental conditions. Depending on the stage of development and condition at time of harvest and in the market, fruits, melons, and tomatoes will go through a ripening phase before starting to decay.

Grains, dry edible beans, and dry field peas are among the less perishable foods that need not be changed in form for storage. If conditions are right[4] at time of harvest, marketing wastes and losses in these foods can be kept to a minimum at much less cost than for more perishable foods.

Marketing wastes and losses from natural causes include those caused by external factors— disease, insects, and rodents. Many of these can be controlled by biological and chemical sprays or baths, satisfactory storage conditions, and other means. Such measures of control are increasingly employed as new methods are applied or old ones are more widely used.

Damages arising from mechanical causes also lead to wastes and losses in the marketing of food. Included in this category are mishandling of the commodity, inadequate containers, improper packaging, and failure of machinery and equipment to function properly.

Where Do They Occur?

Wastes and losses occur at all levels of food marketing channels, but they are discovered most often at certain points in the system. It is logical to expect their discovery to be concentrated (1) at or near the first point at which food enters marketing channels, because this is where the basic sorting and grading occurs most frequently; (2) at the time perishable commodities are moved out of storage; and (3) at the end of the marketing channel—mostly the retail store.

Sometimes the point in the marketing system at which waste and loss in an individual shipment of food occurs is determined by chance. Damage to fresh fruits and vegetables that is caused by a latent or a "market" disease can occur at almost any time. This will depend upon the degree of

[2] The exception is milk, which comes from a living form.

[3] The meaning of the term "harvest" varies with the commodity. For meat, harvest occurs when the animal is slaughtered; eggs, when laid; milk, when drawn from cow; fruit, when picked from tree; food crops, when gathered, dug from the ground, or collected in various other ways.

[4] "Right" weather conditions are those in which grains and other field crops can ripen properly before harvest.

success of man-made controls over environment in keeping disease in check in a particular situation. Whenever damage occurs, however, it may not be discovered until food containers are opened in a retail store. Because wastes and losses occur at all levels, analyses of individual commodities or of groups, by marketing channel, should be made at several stages in the distribution system and at several times for each stage in order to ascertain any patterns.

What Is the Extent of Wastes and Losses?

Because we lack adequate statistical data, knowledge of the extent of wastes and losses of food in marketing is limited. Available data from various sources furnish us directly only a part of the total information needed—usually they are developed to meet individual or specialized accounting and statistical needs. For a more complete picture of wastes and losses, new data are required.

Data on wastes and losses are available from inspection reports of Federal Government agencies and others, food marketing studies, and reports of consolidated damage claim payments of some groups of freight carriers. These data are discussed in the next few paragraphs, together with some of their limitations. Mainly, this discussion examines the coverage of commodities or firms in the industry, the method of reporting, and definitions of waste or loss.

USDA inspection records are a good source of data on wastes and losses of red meats over several decades, and, beginning in 1959, of chicken and turkey meat, at the primary distribution level. All livestock slaughtered under Federal inspection and virtually all poultry meat that is intended for interstate commerce [5] must undergo an antemortem and postmortem inspection. Analysis of the consolidated inspection reports provides reliable data on wastes and losses of (1) animals and fowl between time of sale by grower and time of slaughter, and (2) meat at the primary stage in the marketing channel.

As a basic source of data for marketing wastes and losses, inspection reports for fresh fruits and vegetables are not as good as those for meats. Inspection of fresh fruits and vegetables is made only on request, and the request for inspection in terminal markets usually is made only when the first receiver believes that the quality of the produce has failed to meet specifications agreed upon between him and the shipper. On a rising or high market the receiver may tend to be a little more lenient as to whether specifications are met than he would in a declining or low market.

Individual *market research reports* issued by the U.S. Department of Agriculture and other researchers contain some information on wastes and losses of food in marketing, but they relate only to a specific commodity or group, at a specific level or function in the marketing channel, and during a specified period. Studies on the cost of retailing selected fresh fruits and vegetables in Pittsburgh during 1949–50, conducted by the Department, contain some data on wastes and losses. In connection with studies on the relocation of the wholesale food market in Detroit, New York City, and San Francisco, estimates were obtained on food wastes and losses in wholesale channels there.

Data on the value of claims paid on losses and damage in transit are available from *voluntary reports furnished the Association of American Railroads and the American Trucking Association* by their members. But only limited use can be made of these data because a good part of the perishable foods is transported by truckers who are not members of the ATA and do not report to the Association. Truckers of unmanufactured foods are exempt from Federal regulations other than those relating to safety and drivers' hours of service—they are not required to report on their operations to any Federal agency.

Consolidated data on claims payments cannot be converted directly to an equivalent physical quantity or other economically relevant basis because they are available for broad commodity groups only, and statistics on losses and quality deterioration are not reported separately. The reports include information only on claims paid. The amount paid on claims is frequently based on negotiation between the shipper and carrier and does not always reflect the full extent of the loss or damage. Then, too, at times when market supplies are relatively light and poor quality merchandise can be sold at a price that is satisfac-

[5] In 1959, production under Federal inspection was equivalent to about three-fourths of total production of meat and poultry, respectively.

tory to the shipper, loss and damage claims tend to be lower than during other periods.

Some Major Economic Alternatives

The basic choice is whether to accept wastes and losses that accompany the movement of food to market or to attempt to reduce them. These decisions are continually made by food producers, processors, and distributors. When such a choice is possible, the selection is based on actual or anticipated relative costs and returns.[6] For some commodities, the choice may not be possible because of the current state of technology, lack of knowledge of technological possibilities, or the high costs involved.

Assuming that alternatives are available, an important choice involved in the determination that it pays to reduce wastes and losses in food marketing and the decision that it should be attempted may be whether to encourage the changes at the farm level or in the marketing system. These changes are technological or managerial, or some combination of the two. The various possible choices both as between changes at the farm and within the marketing system, and within each sector, are not mutually exclusive. The changes may come singly or in combination and over a relatively short or long period of time. For example, research is continually underway to develop disease-resistant varieties of muskmelons. At the same time, work is being done to reduce the incidence of physical damage to melons in the marketing process through the development of better containers and better methods of shipping and handling.

On the farm, the changes involve the development and expanded use by farmers of (1) species of livestock and varieties of crops which are more acceptable by the market and which will hold up better in the marketing process than did their predecessors, or (2) improved production (including harvesting) techniques which have the ultimate effect of reducing wastes and losses identified in the marketing system.

Minimizing wastes and losses within the food-marketing system involves one or more choices among several actions. These actions, which are complementary rather than competing, include:

1. Investment in plant, machinery, and equipment.
2. Use of improved food containers and wrappers.
3. Improvement of management practices, such as better scheduling of merchandise receipts from suppliers and deliveries to customers, and more efficient utilization of available plant, machinery, equipment, and manpower.
4. Changes in marketing patterns and channels of distribution.
5. Production of new forms of food, such as acceptable manufactured forms of hitherto unmanufactured foods.
6. Engaging in research to develop or improve food products or to reduce marketing costs.

The decisions made by an individual marketing firm to increase its net return by reducing wastes and losses in food marketing (or the research undertaken for the purpose) are conditioned by the nature of the problem, the techniques and equipment available, and knowledge of the existence of these techniques.

Existing economic alternatives in the reduction of wastes and losses in food marketing are in fact not all equally available to all interested parties. Size of firm may be a factor. For some commodities, few individual firms are large enough to encourage directly those changes at the farm level that will reduce wastes and losses in marketing. This occurs in the production of vegetables under contract for canning or freezing. The contract terms may range from the one extreme in which the packer just obligates himself to buy at a prearranged price all or part of the output from the contracted acreage, to the other extreme in which the processor provides seed, fertilizer, machinery, production supervision, and labor in order to feel reasonably assured of obtaining the quantity of a particular quality of vegetable he wants to pack. An example in which size of firm would be a factor is when a large or a medium-sized firm may find it necessary, because of considerations of cost, to use automatic devices for handling commodities. A small firm may find it more economical to use manual equipment mainly because of a smaller physical volume of business.

[6] For the firm or industry, costs and returns are in monetary terms; for the Government—whether Federal, State, or local—they are in terms of public welfare.

Some Economic Implications

Changes aimed at reducing wastes and losses in food marketing have economic implications for both agriculture and consumers in general, as well as for the food marketing industries. Both the agricultural and the nonagricultural sectors are affected economically by the basic decision as to whether to accept wastes and losses in food marketing. The decision is whether, and to what extent, to rely on factors of production in agriculture or in the marketing system to provide the additional supply of food needed by an increasing domestic population and by the world market. The answer to this is based largely on relative costs of farm and marketing resources.

It may be less expensive to accept wastes and losses in marketing and to depend on the expansion of production to supply increasing needs. With the amount of land available for commercial production of agricultural commodities likely to change little in the years ahead, expanded production of food can come about through changes in land use patterns, more efficient use of land, and improvements in both technology[7] and the ability of farmers to use the technology efficiently.

Over the years, technological developments in agriculture have resulted in more efficient production and better products, as well as in making an important impact on other sectors of the economy through the creation of a demand for specialized machinery and equipment and for synthetic fertilizers, to mention two examples. Some technological advancements have brought about a reduction of wastes and losses in marketing. Development of varieties of food crops that hold up better in the marketing process is one example.

The economic consequences of change for the purpose of reducing wastes and losses in food marketing depend largely on the objectives sought, the commodity involved, and the structure of the market. Basically, the objective sought is reduction of costs—labor or other inputs, product, or some combination of these. For the individual firm, the decision to make certain changes that may reduce wastes and losses has an important bearing on whether it will survive, and on its competitive position in the industry. An industry group may undertake research aimed at finding ways of reducing wastes and losses in order to enable the products handled by its members to compete more successfully with corresponding imports and with substitutes. From the public standpoint, among the important objectives are better use of available resources and the continued improvement of diets for an increasing civilian population.

The economic impact on agriculture of reductions in marketing wastes and losses varies with the commodity. It depends on the elasticity of both supply and demand for the item. For some, the reductions in waste and losses may result in an expansion of the market. An outstanding example is the impact of the development of frozen orange juice concentrate on the demand for oranges at the farm level. The development was a result of the continuing search for a processed orange juice that tasted like the fresh product, and that was more convenient to use than the fresh fruit and much less perishable.

Increased consumer use of frozen orange juice concentrate during the last decade largely reflects the combination of a number of factors. To some extent, consumers substituted the product for both fresh oranges and the various canned single-strength citrus juices, with the increase for the frozen juice more than offsetting equivalent reductions for the other two. The increase for the frozen orange juice concentrate reflected an expansion in both the per capita quantity used and the number of people using it. The net effect has been that over the last decade the market has been able to absorb considerably larger crops of oranges than the population increase alone would have warranted, and at prices that have encouraged growers in Florida to expand productive capacity for oranges.

For potatoes, reductions in wastes and losses have meant that less production was needed to meet consumer demand. However, the major impact on potato growers has been the long-term downtrend in per capita consumption of the fresh product.

[7] "Technology" is here used in its broadest sense, to include improved machinery and equipment; better fertilizers, insecticides, and pesticides; higher yielding crops; species of cows that are more efficient milk producers; species of meat animals that utilize feed and roughage efficiently in terms of producing a commercially desirable carcass in the shortest possible time, and so on.

Distribution of the benefits accruing from reductions in food-marketing wastes and losses by actions of marketing agencies depends on both the supply and the demand elasticities for the final product, the structure of the market with respect to competition, the extent to which knowledge of waste and loss reduction is spread within the industry, and the objective of the firm in making the change. These factors condition the extent to which the gains are retained by the firm, passed back to the farmer in the form of higher buying prices, or passed on to the consumer in the form of lower selling prices. For example, if only one firm possesses knowledge of how to reduce certain wastes and losses, it may retain the gains or pass them on, in part or in full, to consumers in an attempt to gain a larger share of the market. On the other hand, in another type of market situation, pressure of competition from other firms in the industry or other products may force the firm to pass the full benefits on to the consumer. In this situation, all the firm may hope to accomplish is to retain its share of the market.

The decision of the firm as to whether to make changes leading to reductions in food-marketing wastes and losses, the nature of the change—if any—and the timing of such a change may be spontaneous or induced. An example is the situation in which a processed form of a commodity is introduced when previously it was available only in the unprocessed form. The firm's decision as to whether it stands to gain anything by marketing such a product, and the type of action to take, may be dictated by what other firms in the same or other industries have done or are expected to do, or by anticipations of changes in consumer tastes.

Conclusions

This article has sought to clarify concepts of wastes and losses in food marketing, and to present some of the related economic concepts. The necessary research now underway represents an attempt to quantify and appraise the cost—in terms of resources and value—of past and prospective major changes in agriculture and in the marketing system involved in minimizing such wastes and losses. The study is planned to cover individual food groups and subgroups, as well as the total of all major foods.

Adequate quantity and value data by commodity group, especially as they relate to the corresponding total movement through marketing channels, would provide researchers in Government agencies, colleges and universities, and industry with a basis for evaluating (1) the relative cost of current changes aimed at reducing wastes and losses, and (2) the relative merits of research aimed at eventual accomplishment of this goal. The statistics developed would be useful also for estimating or checking the percentages currently used to estimate how much of the food at the primary distribution level reaches consumers at the retail level.

Book Reviews

Methods of Correlation and Regression Analysis, Linear and Curvilinear. Third Edition. By Mordecai Ezekiel and Karl A. Fox. John Wiley & Sons, Inc. 548 pages. $10.95.

THE GENERATION of agricultural economists who have looked on Ezekiel's *Methods of Correlation Analysis* as both primer and encyclopedia will welcome the third edition as an updating of the more familiar editions. Brought out under joint authorship, it will occupy a respected position beside the earlier volumes as an authoritative work in this important area of analysis.

It is, of course, not a new book, but clearly a revision of the earlier editions. Most of the chapters of the second edition and much of the text are retained. Some examples are retained, others are altered, and new ones are added. Scarcely a chapter of the earlier edition, however, escaped at least a modicum of reworking to clarify, to modernize, or to present more clearly the authors'

viewpoints on concepts under discussion. The reader will be the richer as a result.

The many friends of both authors will rejoice too at the joining of their talents in the new edition. They will find therein the same simplicity of approach, the same readability, the same logical development of the argument, the same free use of carefully worked examples, and above all, the same insistence upon the necessity for a reasoned analysis of a problem before undertaking statistical manipulation, that characterized earlier editions.

But readers will find also a number of changes. First noticed, of course, is the new title, *Methods of Correlation and Regression Analysis*, *Linear and Curvilinear*, which, as noted in the preface, was adopted "In recognition of the increased emphasis given to regression analysis in general, . . ." The treatment reflects the modern trend not only in this direction, but in others, as for example, in the free use of the idea of interval estimates. Readers will welcome several new chapters, particularly chapter 20, "The Use of Error Formulas with Time Series." This completely reworks the earlier treatment and gives the authors' mature evaluation of the application of regression analysis to time series.

The last 30 years have seen considerable research in this area, and a number of workers have offered contributions with respect to the limitations on conventional error formulas imposed by successive observations in time as opposed to random sampling, and to finding appropriate modifications to these formulas to compensate for the limitations. The authors draw on the work of Koopmans, Wold, Bartlett, R. L. Anderson, Hart, D. Cochrane and G. H. Orcutt, and others. They present helpful examples of the handling of autocorrelation and the use of von Neumann's ratio, together with tables. This chapter will furnish a measure of assurance to those who have become overly apprehensive concerning the time series problem, and at the same time it should flash a warning to those who would regard too casually the special problems thereby imposed. However, the student who aspires to work confidently in this tricky area will need to explore carefully on his own account, not only the references listed but other literature as well.

A new and helpful chapter on the analysis of variance, largely the work of Karl Fox, appears in this edition. Many readers will join this reviewer in wishing that much more had been made of this highly potent technique and will wonder why the excellent opportunity to explore the analysis of covariance was not pursued.

Another new chapter on "Fitting Systems of two or more Simultaneous Equations" provides a welcome introduction to the concepts involved in the use of "structural equations," following the lead of Haavelmo. This is a valuable addition to the book, and students seeking a point of departure for studying this technique will find the chapter very helpful, including as it does the introduction in elementary form to the concepts involved in the terms "just identified," "overidentified," "exogenous," and "endogenous." Illustrations are kept to manageable size and attention is centered on basic logic and concepts. But students who aspire to more than a casual acquaintence with this field will need to carry their study well into the references.

The chapter on areas in which correlation and regression analysis have been applied is expanded, and here indeed the list of references—with 202 citations—is impressive.

The format of the revised edition is improved in several respects. However, many readers will miss the convenient reference that would have been provided by numbering sections within chapters and carrying the chapter section number at the top of each page, as is the practice of some publishers. Also, users generally will wish that the tables and nomographs had been collected in one place for convenient working reference, instead of distributed through the text.

The third edition adopts generally the now virtually universal practice of using Greek characters for population parameters and Latin characters for sample statistics, a welcome updating of the earlier editions.

In appendix 2 on "Methods of Computations" the authors confine themselves to an explanation of solutions in terms of the matrix of the $\Sigma x_i x_j$ and of the augmented matrix, but do not include solutions in terms of the r_{ij} matrix. It seems that an authoritative treatment should not exclude a discussion of this approach.

The statistically sophisticated reader will miss fuller reference to the t-test and the pioneer work of W. S. Gossett than is provided in the discussion of small samples.

Like its predecessors, the third edition begins the development of the concepts of relationship and their measurement with the most elementary cases, and proceeds with a sure touch to the more advanced aspects step by step, thus providing to students safe conduct through a complex subject matter. Students who have thorough grounding in basic statistics and who come to the third edition for specialization in correlation and regression will be tempted to read on a highly selective basis—a temptation they would do well to resist—for comments by the authors along the way go far to develop insight into the confident use of these methods in productive research. But students who wish to master the theoretical background of the subject will find it necessary to delve heavily into the references, for this book is directed rather more to the operator—to one who wants to know *how* to apply a given technique—than to one who wants to know *why* the method works, where the error formulas come from, why they are valid, and when and why limitations are sometimes imposed on them.

B. R. Stauber

The Australian Wool Market—1840–1900. By Alan Barnard. Melbourne University Press New York: Cambridge University Press. 231 pages. 1958. $6.50.

A DETAILED historical analysis of the development of the marketing institutions is given major emphasis by Dr. Barnard in this review of the Australian wool market from 1840 to 1900. Preceding this analysis is a discussion of the production and consumption of Australian wool, its growth and location, changes in demand, organization of the textile industry, and competition from other national fibers. A brief summary of marketing costs, prices, and price movements—limited by the availability of statistical data—concludes the book.

Dr. Barnard's thorough analysis of the organization and function of the wool market during the last half of the 19th Century is a result of the labor of assembling and analyzing a wealth of reference material in both Australia and the United Kingdom. A great deal of this was from unpublished papers, supplemented by records and files of individuals and companies involved in the development of this market.

From 1840 to 1900, marketing of Australian wool changed from a centralized market in London to one in Australia. In the 1840's, half of the clip was disposed of in central auction sales in England on behalf of general merchants, 30 to 40 percent was consigned to England sales agents on behalf of the growers, and the rest was shipped directly by the growers. By the 1860's, 80 percent was consigned for sale in England, at the risk of growers, largely through specialized wool-consignment agencies. But by the turn of the century, half of the production was sold by auction in Australia.

An analysis of the important marketing functions shows the changes and improvements made in these services as the marketing pattern turned to local auctions. Major emphasis is placed on market information, grading, transportation, storage, distribution, risk bearing, and financing. The economic factors that affect the competitive market practices and the development of specialized banking and marketing agencies for the handling of wool in the central Australian markets are thoroughly covered.

Dr. Barnard describes the role played by the pastoral industry in the economic development of Australia during the 19th Century. Wool did not provide a large part of Australia's national income or employment during this period, but did give use to a substantial demand for investable funds and private capital. Subsequently, wool became the dominant export commodity. This encouraged the growth of marketing services. Wool also had an important influence on the social and political development of Australia during this period. This book provides a good historical analysis of the wool industry during 1840–1900 and provides a firm basis for understanding the nature of importance of subsequent development.

Charles E. Raymond

Food, America's Biggest Business. By Pauline Arnold and Percival White. 338 pages. Holiday House, New York. 1959. $3.95.

THIS BOOK provides a quick tour of America's food industry. Covered here in broad outline is nearly every aspect of the food business, from farming through processing, packaging, and distribution.

Although 4 of the book's 26 chapters are devoted to agriculture, the main emphasis is on processing and distribution. Separate chapters deal with baking, canning, freezing, meat processing, packaging, wholesaling, retailing, and advertising and promotion. The cereal, meat, dairy, poultry and egg, and fishery groups of food receive considerable attention. Surprisingly though, the fruit and vegetable groups are relegated to a chapter entitled "Et Cetera, Other Things To Eat," and follow a discussion of tea and coffee, sugar, and candy. The book closes with a chapter on research and development in which the authors speculate, in a rather romantic mood, on the wonders yet to come.

Treatment is historical and descriptive, with special emphasis on technological development. The book is written for the layman, and contains an abundance of anecdotal and feature type material. Inevitably, the range of the subject matter covered precludes much detail. Statistics are held to a minimum. A few economic charts are included, but most of the book's many illustrations are line drawings.

The authors address the book "primarily to students—in or out of school." For this group, it should be excellent; certainly there is a wealth of suggestions for themes and term papers. The volume should be a valuable addition to the libraries of those engaged in food promotion or advertising. It should be equally useful to the vocational counselor for guidance of youngsters considering the food business as a career. A chapter on this subject is included. The general reader interested in an overall view of the complex food industry should find here both entertainment and useful information.

Wayne V. Dexter

Food Research Institute Studies. Food Research Institute, Stanford University, Stanford, Calif.

THE FOOD Research Institute of Stanford University has begun publication of *Food Research Institute Studies* which will contain articles by staff members reflecting their current research interests. It will be published three times a year, in February, May, and September.

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Colleges [1]

CHRISTENSEN, R. P., JOHNSON, S. E., AND BAUMANN, R. V. PRODUCTION PROSPECTS FOR WHEAT, FEED, AND LIVESTOCK, 1960–65. U.S. Dept. Agr. ARS 43-115, 47 pp., illus. Dec. 1959.

With continuation of present prices, costs, and farm programs (including 28 million acres in the Conservation Reserve Program) we should expect excess production of wheat and feed grains during the next 5 years unless serious drought intervenes. Increased demand arising from population growth is likely to be more than offset by the expanded output resulting from continued increases in crop and livestock production.

CONLOGUE, R. M. CANDLING AND CARTONING EGGS AT COUNTRY PLANTS. U.S. Dept. Agr. Mktg. Res. Rept. 366, 16 pp., Dec. 1959.

[1] State publications may be obtained from the issuing agencies of the respective States.

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Candling and cartoning eggs at country assembly point, rather than at distant market, can save as much as 6 cents a dozen in marketing costs. The change from traditional methods of marketing would involve developing a high-quality egg program in which producers provide assemblers with eggs that run near 90 percent Grade A, or better the year round. Also, the eggs must be moved directly from the assembly plant to established markets in metropolitan areas. Some assemblers have demonstrated that these practices can be developed satisfactorily.

Frye, R. E., and Grubbs, V. D. promotion of farm products by agricultural groups. U.S. Dept. Agr. Mktg. Res. Rpt. 380, 27 pp. Jan. 1960.

Slightly over 1,100 agricultural groups in the United States engaged in promotion during late 1958 and early 1959. These groups spent about $67 million during the fiscal year ending in 1958 for the promotion of agricultural products. More than half of the total promotional expenditures was for advertising, about 23 percent for public relations and consumer education, and about 17 percent for merchandising aid. About $1.4 million was spent on research relating to promotion.

Gerra, M. J. the demand, supply, and price structure for eggs. U.S. Dept. Agr. Tech. Bul. 1204, 157 pp., illus. Nov. 1959.

Describes major relationships that affect the demand for and supply of eggs. These forces are quantified in a statistical model so that estimates of the effect on price of variations in the factors affecting demand and supply can be obtained.

Howell, L D. changes in american textile industry. competition—structure—facilities—costs. U.S. Dept. Agr. Tech. Bul. 1210, 337 pp. illus. Nov. 1959.

Prospective demand for textiles indicates that consumption of American cotton and wool can be maintained or expanded if all potential markets are fully exploited. To meet competition from synthetic and foreign-grown fibers successfully would require that adequate and dependable supplies of suitable qualities of cotton and wool be readily available to users at competitive prices. This, in turn, would require improved efficiency in producing and marketing cotton and wool and in manufacturing and distributing the products.

Leonard, L. A. assessment of farm real estate in the united states. U.S. Dept. Agr. ARS 43–117, 19 pp. Feb. 1960.

Variation of average assessment levels among local assessing units within States, and the economic and fiscal effects of variations in farm assessments are analyzed, difficulties encountered in improving the assessment process are discussed, and steps that have been and are being taken toward such improvements are described.

LeRay, N. L. employment and underemployment of rural people—low-income groups in arkansas, maryland, and west virginia. U.S. Dept. Agr. ARS 43–109, 26 pp., illus. Dec. 1959.

Unemployment and underemployment can be decreased among these low-income groups by making adjustments within agriculture, by increasing nonfarm opportunities in the area, and by migration of workers to other areas. Part-time farming provides an opportunity for nonfarm work while retaining the security of living on a farm. The rural Development Program offers a promising approach to the development and conservation of the human and natural resources of the low-income areas studied.

Magee, A. C., and Rogers, R. H. combining livestock with cash crops on blackland farms. Texas Agr. Expt. Sta. MP–376, 11 pp., illus. Oct. 1959. (Agr. Res. Serv. cooperating.)

Operations on more than 100 farms were studied in 1957 to learn how farmers have combined livestock with cash crops to increase returns, to utilize available labor fully, and to sell homegrown feeds and forage through meat animals and poultry. Average prices received and paid in 1957 were used to develop enterprise budgets for typical farm situations. These budgets can be used to guide farmers in considering one or more of the livestock systems to be added to cash production.

Southern, J. H., and Hendrix, W. E. incomes of rural families in northeast texas. Texas Agr. Expt. Sta. Bul. 940, 32 pp., illus. Oct. 1959. (Agr. Res. Serv. cooperating.)

Of the rural families in the 24-county area studied in 1955, 49,000 were farm families and 39,000 were nonfarm families. Median net money income per rural family was about $2,000. Twenty-seven percent of the families had incomes of less than $1,000, with an average of about $500; and 22 percent had incomes of only $1,000 to $1,999, with an average of $1,450.

Statistical Compilations

Masucci, R. H. dollar volume of agriculture's transactions with industry. U.S. Dept. Agr. Mktg. Res. Rpt. 375, 38 pp. December 1959.

Strickler, P. E., and Hines, C. A. numbers of selected machines and equipment on farms, with related data. U.S. Dept. Agr. Statis. Bul. 258, 30 pp. illus. (Agr. Res. Serv. and Agr. Mktg. Serv. cooperating.) Feb. 1960.

U.S. Agricultural Research Service. food consumption and dietary levels of households as related to the age of homemaker, united states—by region. U.S. Dept. Agr. Household Food Consumption Survey 1955, Rpt. 14, 134 pp. illus. Oct. 1959.

U.S. Department of Agriculture and U.S. Department of Commerce. supplement to published reports on survey of farmers' expenditures in 1955. production expenses—family living expenses—expenditures for motor vehicles and machinery. (A cooperative survey by Agr. Mktg. Serv., Agr. Res. Serv., and Bur. Census.) U.S. Dept. Agr. AMS–354, 79 pp. Dec. 1959.

AGRICULTURAL ECONOMICS
RESEARCH

Is published quarterly by the Agricultural Marketing Service, U.S. Department of Agriculture. The printing of this publication has been approved by the Bureau of the Budget, Feb. 10, 1959.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. 20 cents a single copy, 75 cents a year, domestic, $1 foreign.